

TITLE OF THE INVENTION

CAMERA WITH POSITIONING CAPABILITY

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based on Japanese Patent

5 Applications No. 11-278677, filed September 30, 1999;
No. 11-278678, filed September 30, 1999; and
No. 11-302451, filed October 25, 1999, the contents of
which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

10 The present invention relates to a camera with a
positioning capability.

A positioning apparatus which is used in
GPS(Global Positioning System)-based position
determination (hereinafter called "GPS positioning
apparatus") determines the current position (local
15 position) based on positioning information sent from a
plurality of GPS satellites. Such a GPS positioning
apparatus is incorporated into an on-board navigation
system or the like and is used to determine and display
the local position (coordinates). Some GPS positioning
20 apparatuses manufactured are of the size that can be
installed into a wrist watch.

With such a small GPS positioning apparatus
installed into a digital camera or a silver halide
25 camera to measure the position of the camera, it is
possible to, for example, automatically record the
photographing location or the like in association with

each photographed image. It is therefore expected that the utilization of the GPS positioning apparatus can further improve the usability or operability of cameras and contribute data collection by the cameras.

5 In this case where the GPS positioning apparatus is incorporated into, for example, a digital camera, however, when this GPS positioning apparatus is activated at the time the camera picks up an image, power consumed by the GPS positioning apparatus is
10 added to power consumed by the drive system and image processing system of the camera in picking up the image. This requires a larger current than the current that is needed when the GPS positioning apparatus is not incorporated, thus significantly shortening the battery
15 life.

Even when the GPS positioning apparatus is incorporated in a silver halide camera, power consumed by the GPS positioning apparatus is likewise added to power consumed by the drive system that is operated at
20 the time of picking up an image (because the drive systems of recent silver halide cameras are electronically controlled). This case therefore also has a problem on a shorter battery life.

There is another shortcoming such that a noise component which is generated by the photographing process adversely influences the GPS positioning apparatus, so that positioning may not be performed
25

properly.

In this case, one may incorporate the GPS positioning apparatus in a digital camera to acquire positional information of the digital camera every time a picture is taken, store the information as positional information of the photographed image and display the photographing location together with the photographed image at the time of reproducing the image. However, the time of positioning by the GPS positioning apparatus varies from about 1 second to about 10 seconds, depending on the positional relationship with GPS satellites as mentioned above or the reception environment. If a user tries to activate the GPS positioning apparatus to acquire positional information every time a picture is taken, the user may have to wait for about 10 seconds for each photographing and may not be able to take shots consecutively without much intervals. (A similar problem would occur when the GPS positioning apparatus is incorporated into a silver halide camera.)

Doing position determination every time photographing takes place requires the same number of positioning actions as the number of shots or increases the load at the time of photographing. This leads to increased power consumption.

Some electronic cameras, such as a digital camera, is equipped with a so-called "series photographing

capability" which continuously picks up a predetermined number of images over a predetermined time interval when a user depresses the shutter button once or keeps depressing it.

5 With a small GPS positioning apparatus installed into such a digital camera or a silver halide camera equipped with the series photographing capability to measure the position of the camera, it is possible to, for example, automatically record the photographing
10 location or the like in association with each photographed image. It is therefore expected that the utilization of the GPS positioning apparatus can further improve the usability or operability of cameras and contribute data collection by the cameras.

15 In this case, one may incorporate the GPS positioning apparatus in a digital camera equipped with the series photographing capability to acquire positional information of the digital camera every time photographing takes place, store the information as
20 positional information of the photographed image and display the photographing location together with the photographed image at the time of reproducing the image.

As mentioned above, however, the time of positioning by the GPS positioning apparatus varies
25 from about 1 second to about 10 seconds, depending on the positional relationship with GPS satellites as mentioned above or the reception environment. If a

user tries to activate the GPS positioning apparatus every time an image is picked up in the series photographing action to acquire positional information, the photographing time interval is likely to vary as in
5 the following example. Even if series photographing takes place at the same photographing location, the positioning time may be changed by a change in the reception conditions, or if series photographing takes place while moving, the positioning time may be changed
10 by due to the influence of the reception environment (the attenuation, reflection or the like of received radio waves caused by the landscape, buildings, etc.). If the user acquires positioning information every time a picture is taken and associates the positioning
15 information with each photographed image (each of serially photographed images), the photographing time interval follows up the positioning time and is thus likely to vary.

Doing position determination every time
20 photographing takes place requires the same number of positioning actions as the number of shots or causes the photographing manipulation and the positioning operation to overlap each other, thus increasing the load at the photographing time. This results in
25 increased power consumption.

BRIEF SUMMARY OF THE INVENTION

Accordingly, it is an object of the present

invention to provide a camera with a positioning capability which ensures a longer battery life and prevent a malfunction.

It is another object of this invention to provide
5 a camera with a positioning capability which can reduce the positioning-operation originated load.

It is a further object of this invention to provide a camera and a photographing location memorizing method, which can reduce the load originated
10 from a positioning operation at the time series photographing takes place.

To achieve the above objects, according to the first aspect of this invention, there is provided a camera comprising photographing means; positioning means; positioning timing control means for causing the positioning means to execute positioning at a predetermined timing to thereby obtain positional information; memory means for storing a plurality of images photographed by the photographing means; and
15 memory control means for storing the positional information obtained by the positioning timing control means in the memory means in association with the plurality of photographed images.

According to the second aspect of this invention,
25 there is provided a camera comprising photographing means having a series photographing capability, for acquiring image data of a subject; positioning means;

timing control means for controlling a timing at which
the positioning means executes positioning to obtain
positional information; series photographing
instruction means for giving a series photographing
5 instruction to the photographing means to carry out
series photographing; series photographing control
means for performing such control as to cause the
photographing means to execute series photographing to
acquire a plurality of photographed images in response
10 to the series photographing instruction given by the
series photographing instruction means; memory means
for storing the plurality of photographed images
acquired under control of the series photographing
control means; and memory control means for storing the
15 positional information obtained by the positioning
means in the memory means in association with the
plurality of photographed images acquired by the
photographing means.

According to the third aspect of this invention,
20 there is provided a photographing location memorizing
method for a camera having photographing means for
acquiring image data of a subject, positioning means
and a series photographing capability, comprising the
steps of causing the positioning means to execute
25 positioning at a predetermined timing to acquire
positional information and causing the photographing
means to carry out series photographing in response to

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a series photographing instruction; and storing a plurality of photographed images acquired by the series photographing and storing the positional information in association with the plurality of photographed images.

5 According to the fourth aspect of this invention, there is provided a camera comprising photographing means for acquiring image data of a subject; positioning means; and positioning timing control means for controlling the positioning means in such a way
10 that positioning is carried out immediately before or immediately after photographing by the photographing means.

15 According to the fifth aspect of this invention, there is provided a camera comprising photographing means; positioning means; positioning timing control means for controlling the positioning means in such a way that positioning is carried out at a predetermined time interval; and positioning information acquisition means for acquiring the positioning information provided by the positioning means immediately before or
20 immediately after photographing by the photographing means.

25 According to the sixth aspect of this invention, there is provided a camera comprising photographing means; positioning means; and control means for controlling a positioning operation by the positioning means and a photographing operation by the

photographing means in such a way that a positioning timing of the positioning means and a photographing timing of the photographing means do not overlap each other.

5 According to this invention, as positioning is performed immediately before or immediately after photographing, the adverse influence on the GPS positioning apparatus or power consumption of the battery is minimized. As positioning is performed to 10 acquire a positioning result before or after a photographing instruction is given, the photographing timing and the positioning timing do not overlap each other. This prevents the battery life from being significantly shortened.

15 As positioning is carried out when a positioning instruction is issued, the positioning operation need not be performed in response to the photographing instruction and can be performed at any location desired by a user. Further, as positioning is 20 performed intermittently to acquire a positioning result immediately before or immediately after photographing, only the photographing operation should be performed in response to the photographing instruction. This relieves the burden put by the 25 photographing instruction.

When the positioning operation and the photographing operation overlap each other, one of them

can be carried out first with priority over the other so that such operational overlapping can be avoided (or consumption of a large current by the overlapping can be prevented). This can make the battery life longer.

5 Because it is possible to previously set the priority of one of the positioning operation and the photographing operation higher than the priority of the other when overlapping of the positioning operation and the photographing operation occurs, an overlapping avoiding operation desired by a user can be executed.

10 This makes the camera easier to use at the time of interval photographing, self-timer based photographing, interval positioning, positioning based on the positioning instruction or the like.

15 Further, as a photographed image obtained by the photographing operation can be stored in association with the positioning result obtained by the positioning operation, it is possible to further improve the usability of the camera and contribute data collection by the camera (data to be collected including not only image data and photographing date but also positional data or the like).

20 Furthermore, as positioning is carried out at a predetermined timing and the positioning result is adapted to a plurality of photographed images, the positioning-oriented load can be reduced. Generally, often is the case that with the motif being unchanged,

the photographing position is not changed at the time of taking a picture but when the user wants to change the location, the camera is powered off during movement and photographing will start with a new motif. Even
5 with single positioning carried out when the photographing mode is started, positional information associated with a photographed image matches with the actual photographing location in most cases. As mentioned above, the photographing location is often
10 changed at the time of changing the motif. With the use of a camera designed to be able to select or set a folder, however, a folder is generally changed or newly provided at the time of changing the motif. This provides the following advantage in addition to the
15 aforementioned advantages. In the case where the location is changed without turning off the camera and a picture is taken with the camera at the new location, positional information of the new location can be adapted to the photographed image.

20 The positional information that is acquired by a positioning operation can be stored in a saving memory in association with each photographed image. When a shutter manipulation is performed during positioning, the positioning is stopped and the held positioning
25 result is stored in association with the photographed image. Therefore, the user can perform the shutter manipulation without being conscious or nervous about

whether or not positioning is being carried out, except for the first positioning, so that the latest positioning result can be stored in association with each photographed image.

5 Positioning is carried out after a picture is taken and the photographed image is stored, and photographing is possible even during positioning so that when a picture is taken during positioning, the photographed image is stored in the memory, and after 10 positioning timing is completed, the positioning result is stored in association with the photographed image currently stored (even with the image which has been picked up during positioning timing and has been stored). The user can therefore take pictures without 15 being conscious of positioning timing at the time of photographing.

Positioning is performed after photographing and storing a photographed image are completed, the positioning result is associated with the photographed 20 image, and when a next shutter manipulation is performed within a predetermined time after a previous shutter manipulation, the image that is picked up by the second shutter manipulation is stored in association with the positioning result so that the 25 user can keep taking pictures without being conscious about positioning.

As positioning is executed at a predetermined

timing and the positioning result is stored in association with a plurality of serially photographed images, it is possible to reduce the load originated from the positioning operation at the time of making series photographing. That is, because positioning is carried out before or immediately after a series photographing instruction is issued, the positioning operation and the series photographing operation do not overlap each other, making it possible to reduce the load originated from the positioning operation at the time of making series photographing. Further, because positioning is carried out immediately before or immediately after series photographing is completed, the user can perform series photographing without being conscious about positioning and the positioning operation and the series photographing operation do not overlap each other. Furthermore, positioning is performed both at the beginning and end of series photographing and positioning information which is interpolated for each of serially photographed images based on their positioning results can be used. This can make the adequate photographing location to be associated with each photographed image even in a case where the photographing location at the beginning of series photographing differs from the photographing location at the end of series photographing, such as a case of moving the camera to serially take pictures in

responsive to the movement of a subject during series photographing or a case of serially taking pictures with a camera in motion like an on-board camera.

Additional objects and advantages of the invention will be set forth in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and obtained by means of the instrumentalities and combinations particularly pointed out hereinafter.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate presently preferred embodiments of the invention, and together with the general description given above and the detailed description of the preferred embodiments given below, serve to explain the principles of the invention.

FIG. 1 is a block diagram illustrating the structure of one embodiment of a camera with a GPS positioning capability according to this invention;

FIG. 2 is a block diagram illustrating the details of a control section shown in FIG. 1;

FIG. 3 is a diagram showing memory allocation of a DRAM shown in FIG. 1;

FIG. 4 is a flowchart illustrating a routine when positioning is performed immediately before

photographing according to a first embodiment of this invention;

FIG. 5 is a flowchart illustrating another example of GPS positioning performed immediately before photographing;

FIG. 6 is a flowchart illustrating a routine when GPS positioning is performed immediately after photographing;

FIG. 7 is a flowchart showing a routine to notify
that GPS positioning is in progress;

FIG. 8 is a flowchart showing a routine in the case of acquiring the result of positioning immediately before photographing by intermittently executing GPS positioning;

15 FIG. 9 is a flowchart showing a routine in the
case of acquiring the result of positioning immediately
after photographing;

FIG. 10 is a flowchart illustrating a routine in
the case of inhibiting photographing until overlapping
of GPS intermittent positioning and a photographing
operation is gone in order to prevent such overlapping;

FIG. 11 is a flowchart illustrating a routine when photographing takes place after positioning is finished;

25 FIG. 12 is a flowchart showing a routine in the
case where intermittent positioning is stopped and
photographing is performed with priority over

positioning;

FIG. 13 is a flowchart showing a control operation in the case where a user selectively sets a priority to positioning or to photographing before photographing and a priority-to-positioning process or a priority-to-photographing is performed according to the result of the selective setting when the photographing timing and GPS intermittent positioning timing overlap each other;

FIG. 14 is a flowchart illustrating a routine in the case where positioning is performed when the camera is powered on according to a second embodiment of this invention;

FIG. 15 is a flowchart illustrating a routine in the case where GPS positioning is performed when the camera is powered off;

FIG. 16 is a flowchart illustrating a routine in the case where GPS positioning is performed when the photographing mode is enabled;

FIG. 17 is a flowchart illustrating a routine in the case where GPS positioning is performed when the photographing mode is disabled;

FIG. 18 is a flowchart showing a routine in the case where positioning information is updated by a photographing interval and is adapted to a photographed image which is acquired thereafter;

FIG. 19 is a flowchart showing a routine in the case where when a picture is taken during positioning

after photographing, the positioning result is also adapted to that photographed image;

FIG. 20 is a flowchart illustrating a routine in the case where when a picture is taken during positioning after photographing, positioning is stopped and previous positioning information is adapted to the photographed image;

FIG. 21 is a flowchart illustrating a routine in the case where the result of positioning executed after photographing is adapted to the photographed image;

FIG. 22 is a flowchart illustrating a routine in the case where positioning is performed before a series photographing start instruction is issued according to a third embodiment of this invention;

FIG. 23 is a flowchart illustrating a routine in the case where positioning is performed after the series photographing start instruction is issued;

FIG. 24 is a flowchart illustrating a routine in the case where positioning is executed after series photographing is completed;

FIG. 25 is a flowchart exemplifying another routine in the case where positioning is executed after series photographing is completed;

FIG. 26 is a flowchart illustrating a routine in the case where positioning is executed during series photographing; and

FIG. 27 is a flowchart illustrating a routine in

the case where positioning information which is interpolated for each of serially photographed images based on positioning information at the beginning and end of series photographing is adapted.

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DETAILED DESCRIPTION OF THE INVENTION

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FIG. 1 is a block diagram illustrating the structure of one embodiment of a camera with a GPS positioning capability according to this invention. A digital camera 100 has a GPS antenna 1a, a GPS processing section 1, an image pickup section 2, a control section 3, an operation section 4, a temporary memory (DRAM) 5, a saving memory (flash memory) 6, a display section 7 and an unillustrated power supply circuit. A warning display lamp 8 may be provided.

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The GPS processing section (GPS positioning apparatus) 1 includes an RF circuit, an A/D converter, a data register, a counter, a decoder and a control section (microcomputer). The GPS processing section 1 amplifies and demodulates radio waves from a GPS satellite received at the GPS antenna 1a, decodes the acquired satellite data and performs position determination (positioning), such as computation of the local position of the digital camera 100, based on the decoded data. The positioning result from the GPS processing section 1 is sent to the control section 3 that performs the general control of the digital camera 100.

The image pickup section 2 converts the image of a subject into digital data, obtains signal components (hereinafter referred to as "image data"), such as a digital luminance signal and color difference multiplex signal (Y, Cb, Cr data), from the digital data and transfers the image data to the DRAM 5.

The control section 3 can be realized by a microprocessor which, for example, has peripheral circuits, such as a CPU 3a, RAM 3b, program memory 3c and timer 3d, as shown in FIG. 2. The CPU 3a is connected to the GPS processing section 1, the image pickup section 2, the display section 7, the operation section 4, the DRAM 5 and the flash memory 6 by a system bus 9. The CPU 3a performs the general control of the digital camera 100 according to a control program stored in the program memory 3c. Further, the CPU 3a loads programs for individual modes or a positioning timing control program at the time of photographing based on this invention from the program memory 3c in association with a state signal from the operation section 4, and executes and controls the individual functions of the digital camera 100. The program memory 3c is holding constants and menu data in addition to those programs.

When the shutter is fully depressed, the control section 3 reads image data from the DRAM 5, performs compression, such as JPEG compression, on the image

data and stores the compressed data in the flash memory

6. At the time of data reproduction, the control section 3 expands the image data read from the flash memory 6 to restore the image data.

5 The operation section 4 includes a power ON/OFF switch 41, a plus/minus key 45, an unillustrated operation mode select switch and unillustrated function select buttons. When any of those keys and switches is operated, the operation section 4 sends a state signal
10 to the control section 3.

The DRAM 5 is used as a work memory and secures an image buffer area for temporarily storing a photographed image or a reproduced image, and a working area or the like which is used at the time of compression or expansion. In series photographing mode, 15 the DRAM 5 secures a through image memory area 51 and a series photographed image memory area 52 capable of temporarily storing a predetermined number (e.g., 16) of subject images that are fetched at a predetermined time interval, as shown in FIG. 3. Further, a work 20 area 53 is allocated in the DRAM 5. The flash memory 6 stores each photographed image.

[Positioning Timing Control Method At Photographing Time]

25 As mentioned above, when the photographing timing and the positioning timing overlap, a large current is needed, which shortens the battery life or malfunction.

The digital camera 100 according to this invention is so designed as to make the photographing timing and the positioning timing different from each other, thus reducing the power consumption to elongate the battery life or prevent a malfunction.

When the photographing timing and the positioning timing overlap, photographing or positioning may be inhibited or positioning being in progress may be indicated by the display lamp to thereby prevent the photographing timing and the positioning timing overlapping each other. The following will discuss several examples of the positioning timing control method at the photographing time.

FIG. 4 is a flowchart illustrating a routine when positioning is performed immediately before photographing.

In step A1 in FIG. 4, the control section 3 sets the digital camera 100 to a photographing mode, sequentially loads subject images (image data) from the image pickup section 2 into the DRAM 5 and performs through (finder) display of each photographed image on the display section 7.

Next, the control section 3 checks the state signal input from the operation section 4 to check if a shutter button 46 has been depressed half in step A3. When the shutter button 46 has not been depressed half, the control section 3 returns to step A1. When it is

determined that the shutter button 46 has been depressed half, on the other hand, the control section 3 determines that there is a positioning start instruction and locks full shutter depression in step

5 A5. Specifically, the control section 3 sets a prohibition flag for full shutter depression.

Accordingly, even if a state signal corresponding to full shutter depression is input from the operation section 4, the control section 3 does not perform a corresponding operation.

process corresponding to full shutter depression.

Although the half shutter depression operation is treated as the positioning start instruction in this embodiment, this is not restrictive. For example, a positioning start instructing function may be assigned to one of the function select buttons so that when this button is operated during the through-display in step A1 is considered as the positioning start instruction.

20 Next, the control section 3 executes a GPS positioning process in step A7. Specifically, the control section 3 sends a positioning start instruction signal to the GPS processing section 1 to start the GPS positioning process. When receiving the positioning start instruction signal, the GPS processing section 1 activates the GPS positioning apparatus to execute a reception process on radio waves received via the GPS antenna 1a, computes the local position (coordinates) of the digital camera 100 after the reception process

and sends the positioning result (computed value) to the control section 3. After sending the positioning result (computed value) to the control section 3, the GPS processing section 1 proceeds to the next cycle of 5 positioning (which means the next reception cycle of positioning information transmitted from a GPS satellite at every predetermined period).

Then, the control section 3 determines in step A9 whether or not the GPS positioning process has been 10 completed. Upon reception of the positioning result from the GPS processing section 1, the control section 3 determines that positioning has been completed. When having determined in step A9 that the GPS positioning process has been completed, the control section 3 15 unlocks the lock (prohibition) of full shutter depression (sets the prohibition flag for full shutter depression) and proceeds to step A13.

In step A13, the control section 3 receives the state signal from the operation section 4 and 20 determines if the shutter button 46 has been depressed fully. When it is determined that the shutter button 46 has been depressed fully, image data stored in the DRAM 5 is compressed and then stored in the flash memory 6 in step A15. At this time, the positioning 25 result (positional data (coordinate values) of the digital camera 100) or the like acquired by the GPS positioning process in step A7 is also stored in

association with the image data.

With the above-described structure, as one cycle of positioning is carried out to acquire a positioning result in response to the GPS positioning instruction which is given immediately before the photographing instruction in this embodiment, it is possible to prevent an adverse influence on the GPS processing section 1 and minimize the power consumption. Because full depression of the shutter button 46 is locked during the GPS positioning process, the photographing timing and the positioning timing do not overlap each other even when a photographing instruction is given during the positioning timing.

FIG. 5 is a flowchart illustrating another example of GPS positioning performed immediately before photographing.

In step B1 in FIG. 5, the control section 3 sets the digital camera 100 to the photographing mode, sequentially loads subject images (image data) from the image pickup section 2 into the DRAM 5 and performs through-display of each photographed image on the display section 7.

Next, the control section 3 fetches the state signal from the operation section 4 to check if the shutter button 46 has been depressed fully in step B3. When it is determined that the shutter button 46 has been depressed fully, on the other hand, the control

section 3 determines that there are a photographing instruction and a GPS positioning start instruction and proceeds to step B5.

In step B5, the control section 3 sends the 5 positioning start instruction signal to the GPS processing section 1 to start the GPS positioning process. When receiving the positioning start instruction signal, the GPS processing section 1 activates the GPS positioning apparatus to execute a 10 reception process on radio waves received via the GPS antenna 1a, computes the local position (coordinates) of the digital camera 100 and sends the positioning result (computed value) to the control section 3. After sending the positioning result (computed value) 15 to the control section 3, the GPS processing section 1 proceeds to the next cycle of positioning (which means a process of the next received data from a GPS satellite).

Then, the control section 3 determines in step B7 20 whether or not the GPS positioning process has been completed. Upon reception of the positioning result from the GPS processing section 1, the control section 3 determines that positioning has been completed, and compresses image data stored in the DRAM 5 and then 25 stores the compressed image data in the flash memory 6 in step B9. At this time, the positioning result acquired by the GPS positioning process in step B5 is

also stored in association with the image data.

With the above-described structure, as one cycle of positioning is carried out to acquire a positioning result after the GPS positioning instruction is given in this embodiment, it is possible to prevent an adverse influence on the GPS processing section 1 and minimize the power consumption. Because an image storing process (photographing process) is performed after one cycle of GPS positioning process, the photographing timing and the positioning timing do not overlap each other.

FIG. 6 is a flowchart illustrating a routine when GPS positioning is performed immediately after photographing.

In step C1 in FIG. 6, the control section 3 sets the digital camera 100 to the photographing mode, sequentially loads subject images (image data) into the DRAM 5 and performs through-display of each photographed image on the display section 7.

Next, the control section 3 fetches the state signal input from the operation section 4 to check if the shutter button 46 has been depressed fully in step C3. When it is determined that the shutter button 46 has been depressed fully, the control section 3 determines that there are a photographing instruction and a GPS positioning start instruction and proceeds to step C5.

In step C5, the control section 3 compresses the photographed image stored in the DRAM 5 and stores the compressed image data in the flash memory 6.

5 In the next step C7, the control section 3 sends the positioning start instruction signal to the GPS processing section 1 to start the GPS positioning process. When receiving the positioning start instruction signal, as mentioned above, the GPS processing section 1 computes the local position
10 (coordinates) of the digital camera 100 and sends the positioning result (computed value) to the control section 3.

Then, in step C9, the control section 3 stores the positioning result received from the GPS processing section 1 in step C7 in the flash memory 6 in association with the photographed image (image data) stored in the flash memory 6 in the photographing operation in the step C5.

With the above-described structure, as one cycle of positioning is carried out to acquire a positioning result after a picture is taken in this embodiment, it is possible to prevent an adverse influence on the GPS processing section 1 and minimize the power consumption.
20 Because an image storing process (photographing process) is performed after one cycle of GPS positioning process, the photographing timing and the positioning timing do not overlap each other.

FIG. 7 is a flowchart showing a routine to notify that GPS positioning is in progress.

As processes in steps D1 to D5 and D9 to D15 in FIG. 7 are similar to those in steps A1 to A5 and A9 to A15 in FIG. 4, their description will be omitted. As shown in FIG. 7, when determining the half shutter depression in step D3, the control section 3 notifies the user of GPS positioning being in progress in step D6. Specifically, for example, the display lamp 8 is lit (or flickered) or a buzzer sound is generated. This structure may eliminate the need for locking of the full depression of the shutter button 46 in step D5 and unlocking of the full shutter depression in step D11.

Although the photographing process is to store a photographed image in the memory in the examples shown in FIGS. 4 through 6, the photographing process may be the process of the image pickup section (image pickup process) in the case where a camera which uses an optical finder and does not display a through image is designed to operate the image pickup section only when the photographing instruction is given.

The photographing process may be lens driving or image processing for an AF (Auto Focus) operation, lens driving for a zooming operation or a strobe emission process for strobe photographing.

FIG. 8 is a flowchart showing a routine in the

case of acquiring the result of positioning immediately before photographing by intermittently executing GPS positioning.

In this embodiment, a GPS positioning process is
5 carried out at every predetermined time interval
(hereinafter referred to as "intermittent positioning")
to acquire the positioning results before and after
photographing.

In step E1 in FIG. 8, the control section 3 sets
10 the digital camera 100 to the photographing mode, and
sends the positioning start instruction signal to the
GPS processing section 1 to start the intermittent GPS
positioning process. When receiving the positioning
start instruction signal, the GPS processing section 1
15 activates the GPS positioning apparatus at every
designated time to execute a reception process on radio
waves received via the GPS antenna 1a, computes the
local position (coordinates) of the digital camera 100
and sends the positioning result (computed value) to
20 the control section 3. The control section 3
overwrites the content of a positioning result memory
area in the RAM 3b (or DRAM 5) with the positioning
result received from the GPS processing section 1.
(Though not illustrated, this intermittent GPS
25 positioning process is carried out by the GPS
processing section 1 at every predetermined time
interval between steps E1 to E7.)

- In the next step E3, the control section 3 loads subject images (image data) into the DRAM 5 and performs through-display of each photographed image on the display section 7. When the intermittent GPS positioning process is performed during this period,
5 the image loading and through-display process and the intermittent positioning process may be executed in parallel, but image loading may be stopped to suppress overlapping processes and be resumed after the
10 intermittent GPS positioning process is completed.
(An image before stopping the image loading may be displayed directly or a message or a mark indicating that positioning is in progress may be displayed on the display section 7.)
15 Next, the control section 3 fetches the state signal input from the operation section 4 to check if the shutter button 46 has been depressed fully in step E5. When it is determined that the shutter button 46 has been depressed fully, the control section 3 sends a
20 positioning stop instruction signal to the GPS processing section 1 after giving the photographing instruction, thus stopping the intermittent GPS positioning process.
- Accordingly, the result of the intermittent GPS positioning process that has been executed at the closest timing to the photographing instruction is stored in the RAM 3b (or DRAM 5).

In the next step E9, the control section 3 performs compression on the photographed image stored in the DRAM 5 and stores the compressed image data as a photographed image in the flash memory 6. At this time,
5 the positioning result (positional data (coordinate values) of the digital camera 100) acquired by the GPS positioning process is stored in association with the photographed image (image data), after which the flow returns to step E1 to resume the intermittent GPS
10 positioning process.

The order of the processes in steps E7 and E9 may be reversed. That is, when the shutter button 46 is depressed fully in step E5, the result (positioning result) of the intermittent GPS positioning process
15 that has been executed at the closest timing to the photographing instruction may then be stored in association with the photographed image, after which the positioning result after the photographing instruction (before the photographing process) may be
20 acquired. (In this case, intermittent positioning may not be stopped.)

FIG. 9 is a flowchart showing a routine in the case of acquiring the result of positioning immediately after photographing.

25 As processes in steps F1, F3 and F5 in FIG. 9 are similar to those in steps E1, E3 and E5 in FIG. 8, their description will be omitted. After the shutter

button 46 is fully depressed to instruct photographing in step F5 in FIG. 9, the control section 3 compresses image data stored in the DRAM 5 and stores the data as a photographed image in the flash memory 6.

5 Then, in step F9, the control section 3 checks the state signal of the GPS processing section 1 to determine whether or not the GPS processing section 1 has completed the intermittent GPS positioning process. When determining that the intermittent GPS positioning
10 process has been finished, the control section 3 stores the positioning result received from the GPS processing section 1 in association with the photographed image (image data) stored in the flash memory 6 in step F11.

According to this embodiment with the above-
15 described structure, the result of GPS positioning that has been performed intermittently immediately after photographing is acquired. This makes the adverse influence on the GPS processing section 1 and the power consumption of the battery smaller.

20 At the time the result of the intermittent GPS positioning process as illustrated in FIGS. 8 and 9 is acquired, the photographing timing and the positioning timing may overlap each other.

FIG. 10 is a flowchart illustrating a routine in
25 the case of inhibiting photographing until overlapping of GPS intermittent positioning and a photographing operation is gone in order to prevent such overlapping.

As processes in steps G1 and G3 in FIG. 10 are similar to those in steps F1 and F3 in FIG. 9, and their description will be omitted.

When determining in step G5 that the shutter button 46 has been depressed fully, as illustrated in the diagram, the control section 3 checks the state signal of the GPS processing section 1 to determine whether or not the GPS processing section 1 is in operation in step G9. When the GPS processing section 1 is in operation, the control section 3 determines that GPS positioning is in progress and turns on or flickers the display lamp 8 in step G7 to inform the user of positioning being in progress. The digital camera 100 may be provided with a sound output device to notify "positioning in progress" by a sound or voice.

FIG. 11 is a flowchart illustrating a routine when photographing takes place after positioning is finished.

As processes in steps H1 and H3 in FIG. 11 are similar to those in steps F1 and F3 in FIG. 9, their description will be omitted.

When the control section 3 checks the state signal input from the operation section 4 and determines that the shutter button 46 has been depressed fully in step H5, as illustrated in the diagram, the control section 3 checks the state signal of the GPS processing section 1 to determine if the GPS processing section 1 is in operation in step H7. When the GPS processing section

1 is in operation, the control section 3 determines
that GPS positioning is in progress (intermittent GPS
positioning process being in progress) and turns on (or
flickers) the display lamp 8 in step G7 to inform the
5 user of positioning being in progress. The digital
camera 100 may be provided with a sound output device
to notify "positioning in progress" by a sound or voice.

In the next step H11, the control section 3
determines if positioning is completed. Specifically,
10 because the GPS processing section 1 stops positioning
for a predetermined time after sending the positioning
result (computed value) to the control section 3 until
a control signal (positioning start instruction signal)
is sent from the control section 3, the control section
15 3, upon reception of the positioning result from the
GPS processing section 1, determines that one cycle of
intermittent positioning has been completed, and
proceeds to step H13. The subsequent steps H13 and H15
perform similar processes to those in steps G11 and G13
20 in FIG. 10.

When the positioning timing comes during a
photographing process (image storing process in the
embodiment), the positioning process may be executed
after interrupting the photographing process. In this
25 case, after the positioning process (intermittent
positioning) is completed, the interrupted
photographing process may be restarted.

FIG. 12 is a flowchart showing a routine in the case where intermittent positioning is stopped and photographing is performed with priority over positioning.

5 As processes in steps I1 and I3 in FIG. 12 are similar to those in steps F1 and F3 in FIG. 9, their description will be omitted.

In step I5 in FIG. 12, the control section 3 checks the state signal from the operation section 4 to determine if the shutter button 46 has been depressed fully. When full depression of the shutter button 46 is determined, the control section 3 checks the state signal from the GPS processing section 1 in step I7. When the GPS processing section 1 is in operation, the control section 3 determines that GPS positioning is in progress (intermittent GPS positioning process in progress) and goes to step I9.

In step I9, the control section 3 sends a control signal to the GPS processing section 1 to inhibit intermittent GPS positioning once until the current intermittent GPS positioning time elapses. (That is, the current GPS positioning is stopped.) The subsequent steps I11 and I13 perform similar processes to those in steps H13 and H15 in FIG. 11.

25 When a predetermined time elapses after the intermittent GPS positioning process in steps I5 to I9 is inhibited, the next intermittent GPS positioning

process is executed, and the positioning result of the inhibited intermittent GPS positioning process previous by one cycle can be obtained in step I11. In the case of acquiring the positioning result immediately after 5 photographing shown in FIG. 9, the next intermittent GPS positioning process can be executed when a predetermined time passes after prohibition of the intermittent GPS positioning process in step I9. It is therefore possible to prohibit intermittent GPS 10 positioning once when the photographing instruction is issued and acquire the positioning result.

Note that the inhibited positioning process may be carried out after the photographing process is completed. When the positioning timing comes during 15 the photographing process, the positioning process may be prohibited or the positioning process may be executed after the photographing process is completed.

According to this embodiment with the above-described structure, it is determined upon operation of 20 the shutter button 46 whether or not the intermittent GPS positioning process is in progress, and a priority-to-positioning process or a priority-to-photographing process can be executed automatically. Even when the photographing instruction is issued during the 25 positioning timing or the positioning timing comes during photographing, therefore, the photographing timing and the positioning timing do not overlap each

other.

FIG. 13 is a flowchart showing a control operation in the case where a user selectively sets a priority to positioning or to photographing before photographing and a priority-to-positioning process or a priority-to-photographing is performed according to the result of the selective setting when the photographing timing and GPS intermittent positioning timing overlap each other.

When the photographing mode is activated, the control section 3 sends a priority operation select message (or mark) at the time the photographing timing and the positioning timing overlaps to the display section 7 and displays the message on the display screen in step J1, requesting the user of the proper selection. When the user manipulates a key (e.g., the plus key 45) to select the priority operation, the control section 3 stores the selected setting value (e.g., "0" for priority to positioning and "1" for priority to photographing) into the RAM 3b (or DRAM 5).

When determining full depression of the shutter button 46 in step J7 in FIG. 13, the control section 3 checks the state signal of the GPS processing section 1 in step J9. When the GPS processing section 1 is in operation, the control section 3 determines that GPS positioning is in progress (intermittent GPS positioning process in progress) and goes to step J11.

In step J11, the control section 3 checks the

selected setting value set in the step J1 and returns to step J5 when the value indicates priority to positioning (set value = "0") but proceeds to step J13 when the value indicates priority to photographing (set value = "1").

The control section 3 sends a control signal to the GPS processing section 1 to prohibit the intermittent GPS positioning process once until the current intermittent positioning time elapses (the current GPS positioning is stopped) and proceeds to step J15.

When the intermittent GPS positioning process is in progress in the step J9, the display lamp 8 may be lit or flickered to inform the user of that event.

When a predetermined time elapses after the intermittent GPS positioning process is inhibited, the next intermittent positioning process is executed in the step J13 in which the positioning result of the inhibited intermittent GPS positioning process previous by one cycle can be obtained. In the case of acquiring the positioning result immediately after photographing shown in FIG. 9, the next intermittent GPS positioning process can be executed when a predetermined time passes after prohibition of the intermittent GPS positioning process in the step J13. It is therefore possible to prohibit intermittent GPS positioning once when the photographing instruction is issued and

acquire the positioning result.

Although the foregoing description referring to FIGS. 10 to 13 has been given of the case where when the positioning timing and the photographing timing overlap each other at the time of executing the intermittent GPS positioning operation shown in FIGS. 8 and 9, the photographing inhibition (priority to positioning) control or the positioning termination (priority to photographing) control is performed, the photographing inhibition (priority to positioning) control or the positioning termination (priority to photographing) control is not limited to the examples illustrated in FIGS. 8 and 9. For example, such control may be adapted when selective setting of the priority operation is performed or at the time of performing interval photographing, automatic photographing based on a self-timer or the like, or positioning based on the positioning instruction in the example of FIG. 4.

Because this embodiment with the above-described structure selectively sets the priority operation when the positioning timing and the photographing timing overlap each other at the time of carrying out photographing or positioning, and executes a priority to positioning process or a priority to photographing process in accordance with the result of the selective setting, the photographing timing and the

positioning timing do not overlap each other.

Although the GPS processing section 1 goes to the next cycle of positioning after sending the positioning result (computed value) to the control section 3 in the foregoing description of the individual examples, a modification may be made in such a way that after executing one cycle of positioning and sending the positioning result to the control section 3, the GPS processing section 1 interrupts the positioning process or stops the positioning process until an instruction is given from the control section 3.

The second embodiment of this invention will be described below.

If positioning is performed and the positioning result is adapted to a photographed image every time a picture is taken as described above, the positioning operation should be executed each time. The second embodiment is so designed as to adapt positioning information acquired at a predetermined timing to a plurality of photographed images. The adaptation of positioning information may be accomplished by two schemes: one is to store the same positioning information in association with each photographed image in one to one correspondence and the other is to associate one positioning information with a plurality of photographed images and display the positioning information in association with each image at the time

of reproduction. The following will discuss several examples of the positioning timing control and the operation of adapting positioning information to photographed images.

5 FIG. 14 is a flowchart illustrating a routine in the case where positioning is performed when the camera is powered on according to a second embodiment of this invention.

10 In step K1 in FIG. 14, the control section 3 checks a power supply state flag to determine if power is on. When power is on, the control section 3 sends a control signal to the GPS processing section 1 and then proceeds to step K3.

15 When receiving the positioning start instruction signal from the control section 3, the GPS processing section 1 activates the GPS positioning apparatus to execute a reception process on radio waves received via the GPS antenna 1a, computes the local position (coordinates) of the digital camera 100 and sends the 20 positioning result (computed value) to the control section 3 in step K3. After completing one cycle of positioning, the GPS processing section 1 proceeds to the next cycle of positioning (which means the next reception cycle of positioning information transmitted 25 from a GPS satellite at every predetermined period), so that when receiving the positioning result from the GPS processing section 1, the control section 3 sends a

positioning end instruction signal to the GPS processing section 1 to prevent the GPS processing section 1 from going to the next cycle and stop positioning.

5 Next, the control section 3 stores the positioning result (positioning information) received from GPS processing section 1 into the positioning result memory area in the RAM 3b (or DRAM 5) in step K5.

10 In the next step K7, the control section 3 reads process mode select menu data (or icon data) or the like from the program memory 3c and sends the data to the display section 7 and displays it on the screen, prompting the user to make a selection.

15 The control section 3 checks the state signal sent from the operation section 4. When the selected processing mode is the photographing mode, the control section 3 goes to step K9. Although step K7 is positioned after steps K3 and K5 in this embodiment, step K7 may be executed before steps K3 and K5.

20 In step K9, the control section 3 sends a control signal to the image pickup section 2 to fetch a subject image. The image pickup section 2 stores the subject image (image data) into the DRAM 5 via an optical system. The fetched image is also subjected to through-display on the display section 7.

25 Next, the control section 3 checks the state signal sent from the operation section 4 in step K11.

When it is determined that the shutter button 46 has been depressed fully, the control section 3 determines that there is a photographing instruction and proceeds to step K13.

5 In step K13, the control section 3 performs compression on the photographed image stored in the DRAM 5 and stores the compressed image data (as a photographed image) in the flash memory 6. At this time, the positioning result (positioning information
10 (position data (coordinate values) of the digital camera 100)) stored in the RAM 3b in step K5 is stored in association with the photographed image.

15 In the next step K15, the control section 3 checks the state signal from the operation section 4 to determine if there has been an operation to terminate the current photographing mode. When such a termination operation has been performed, the control section 3 proceeds to step K17. When the termination operation is not performed even after a predetermined
20 time passes, the control section 3 returns to step K3 to perform an operation of acquiring the next image.

25 In step K17, the control section 3 checks the state signal from the operation section 4 to determine if there has been an operation to turn off the power switch. When the power OFF operation has been performed, the control section 3 turns off the power and terminates the routine in step K19. When the power

OFF operation is not performed even after a predetermined time passes, the control section 3 returns to step K7 to perform an operation of displaying the selection menu for the next processing mode.

With the above-described structure, positioning is executed when the camera is powered on and the positioning result is saved in association with individual photographed images that have been picked up until the camera is powered off. Therefore, the GPS positioning process has only to be executed once at the time the camera is powered on, so that the user can perform the shutter manipulation without being conscious about positioning (because the user needs not wait for positioning to be completed). With the motif being unchanged, generally, the photographing position is not changed at the time of taking a picture but when the user wants to change the location, the camera is powered off during movement and photographing will start (the camera is powered on) with a new motif. Even with single positioning performed when the camera is powered on, positional information associated with a photographed image matches with the actual photographing location in most cases.

FIG. 15 is a flowchart illustrating a routine in the case where GPS positioning is performed when the camera is powered off.

In step L1 in FIG. 15, the control section 3 checks the power supply state flag to determine if power is on. When power is on, the control section 3 proceeds to step L3.

5 In step L3, the control section 3 reads process mode select menu data (or icon data) or the like from the program memory 3c and sends the data to the display section 7 and displays it on the screen, prompting the user to make a selection.

10 The control section 3 checks the state signal sent from the operation section 4. When the selected processing mode is the photographing mode, the control section 3 goes to step L5.

15 In step L5, the control section 3 sends a control signal to the image pickup section 2 to fetch a subject image. The image pickup section 2 stores the subject image (image data) into the DRAM 5 via the optical system. The fetched image is also subjected to through-display on the display section 7.

20 Next, the control section 3 checks the state signal sent from the operation section 4 in step L7. When it is determined that the shutter button 46 has been depressed fully, the control section 3 proceeds to step L9.

25 In step L9, the control section 3 performs compression on the photographed image stored in the DRAM 5 and stores the compressed image data in the

flash memory 6.

In the next step L11, the control section 3 checks the state signal from the operation section 4 to determine if there has been an operation to terminate
5 the current photographing mode. When such a termination operation has been performed, the control section 3 proceeds to step L13. When the termination operation is not performed even after a predetermined time passes, the control section 3 returns to step L5
10 to execute an operation of acquiring the next image and performing through-display of the image.

In step L13, the control section 3 checks the state signal from the operation section 4 to determine if there has been an operation to turn off the power
15 switch. When the power OFF operation has been performed, the control section 3 sends a control signal to the GPS processing section 1 and then goes to step L15.

When receiving the positioning start instruction
20 signal from the control section 3, the GPS processing section 1 activates the GPS positioning apparatus to execute a reception process on radio waves received via the GPS antenna 1a, computes the local position
25 (coordinates) of the digital camera 100 and sends the positioning result (computed value) to the control section 3 in step L15. After completing one cycle of positioning, the GPS processing section 1 proceeds to

the next cycle of positioning, so that when receiving
the positioning result from the GPS processing section
1, the control section 3 sends a positioning end
instruction signal to the GPS processing section 1 to
5 prevent the GPS processing section 1 from going to the
next cycle and stop positioning.

In step L17, the control section 3 stores the
positioning result received from GPS processing section
10 1 in the step L15 in association with the individual
photographed images (image data) stored in the flash
memory 6 in the photographing operation of the steps L5
to L11. The control section 3 then turns off the power
in step L19.

With the above-described structure, positioning is
15 executed when a series of photographing actions is
completed and the camera is powered off and the
positioning result is saved in association with
individual photographed images that have been picked up
during the power ON duration. This can allow the user
20 to take pictures without being conscious about
positioning. With the motif being unchanged, generally,
the photographing position is not changed at the time
of taking a picture but when the user wants to change
the location, the camera is powered off during movement
25 and photographing will start (the camera is powered on)
with a new motif. Even with single positioning
performed when the camera is powered off, positional

information associated with a photographed image matches with the actual photographing location in most cases.

FIG. 16 is a flowchart illustrating a routine in
5 the case where GPS positioning is performed when the
photographing mode is enabled.

In step M1 in FIG. 16, the control section 3 reads
process mode select menu data (or icon data) or the
like from the program memory 3c and sends the data to
10 the display section 7 and displays it on the screen,
prompting the user to make a selection. The control
section 3 checks the state signal sent from the
operation section 4. When the selected processing mode
is the photographing mode (when the photographing mode
15 is enabled), the control section 3 sends a control
signal to the GPS processing section 1 and goes to
step M3.

When receiving the positioning start instruction
signal from the control section 3, the GPS processing
section 1 activates the GPS positioning apparatus to
execute a reception process on radio waves received via
the GPS antenna 1a, computes the local position
(coordinates) of the digital camera 100 and sends the
positioning result (computed value) to the control
25 section 3 in step M3. After completing one cycle of
positioning, the GPS processing section 1 proceeds to
the next cycle of positioning, so that when receiving

the positioning result from the GPS processing section 1, the control section 3 sends a positioning end instruction signal to the GPS processing section 1 to prevent the GPS processing section 1 from going to the
5 next cycle and stop positioning.

In step M5, the control section 3 stores the positioning result (positioning information) received from GPS processing section 1 into the positioning result memory area in the RAM 3b (or DRAM 5).

10 In step M7, the control section 3 sends a control signal to the image pickup section 2 to fetch a subject image. The image pickup section 2 stores the subject image (image data) into the DRAM 5 via the optical system. The fetched image is also subjected to through-display on the display section 7.
15

Next, the control section 3 checks the state signal sent from the operation section 4 in step M9. When it is determined that the shutter button 46 has been depressed fully, the control section 3 determines
20 that there is a photographing instruction and proceeds to step M11.

In step M11, the control section 3 performs compression on the photographed image stored in the DRAM 5 and stores the compressed image data in the
25 flash memory 6. At this time, the positioning result stored in the RAM 3b in step M5 is stored in association with the photographed image (image data).

In the next step M13, the control section 3 checks the state signal from the operation section 4 to determine if there has been an operation to terminate the current photographing mode. When such a 5 termination operation has been performed, the control section 3 terminates the photographing mode (disables the photographing mode).

With the above-described structure, positioning is executed at the beginning of the photographing mode 10 (when the photographing mode is set on) and the positioning result is saved in association with individual photographed images that have been picked up during the photographing mode. Therefore, the GPS positioning process has only to be executed once at the 15 beginning of the photographing mode, so that the user can perform the shutter manipulation without being conscious about positioning (because the user need not wait for positioning to be completed). With the motif being unchanged, generally, the photographing position 20 is not changed during the photographing mode but when the user wants to change the location, the user moves to a new location with the photographing mode disabled and starts taking pictures with a new motif after enabling the photographing mode again. Even with 25 single positioning performed at the beginning of the photographing mode, positional information associated with a photographed image matches with the actual

photographing location in most cases.

FIG. 17 is a flowchart illustrating a routine in the case where GPS positioning is performed when the photographing mode is disabled.

5 In step N1 in FIG. 17, the control section 3 reads process mode select menu data (or icon data) or the like from the program memory 3c and sends the data to the display section 7 and displays it on the screen, prompting the user to make a selection. The control
10 section 3 checks the state signal sent from the operation section 4. When the selected processing mode is the photographing mode (when the photographing mode is enabled), the control section 3 goes to step N3.

15 In step N3, the control section 3 sends a control signal to the image pickup section 2 to fetch a subject image. The image pickup section 2 stores the subject image (image data) into the DRAM 5 via the optical system. The fetched image is also subjected to through-display on the display section 7.

20 Next, the control section 3 checks the state signal sent from the operation section 4 in step N5. When it is determined that the shutter button 46 has been depressed fully, the control section 3 considers that there is a photographing instruction and proceeds
25 to step N7.

In step N7, the control section 3 performs compression on the photographed image stored in the

DRAM 5 and stores the compressed image data in the flash memory 6.

In the next step N9, the control section 3 checks the state signal from the operation section 4 to determine if there has been an operation to terminate the current photographing mode. When such a termination operation has been performed, the control section 3 proceeds to step N1 (the photographing mode disabled). When the termination operation is not performed even after a predetermined time passes, the control section 3 returns to step N3.

In the next step N11, the control section 3 sends the positioning start instruction signal to the GPS processing section 1. When receiving the positioning start instruction signal from the control section 3, the GPS processing section 1 activates the GPS positioning apparatus to execute a reception process on radio waves received via the GPS antenna 1a, computes the local position (coordinates) of the digital camera 100 and sends the positioning result (computed value) to the control section 3. After completing one cycle of positioning, the GPS processing section 1 proceeds to the next cycle of positioning, so that when receiving the positioning result from the GPS processing section 1, the control section 3 sends a positioning end instruction signal to the GPS processing section 1 to prevent the GPS processing

section 1 from going to the next cycle and stop positioning.

In the next step N13, the control section 3 stores the positioning result received from GPS processing 5 section 1 in the step N11 in association with the individual photographed images (image data) stored in the flash memory 6 in the photographing operation of the steps N3 to N7, and then terminates this routine.

With the above-described structure, positioning is 10 executed when a series of photographing actions and storage of photographed images are completed and the photographing mode is disabled, and the positioning result is saved in association with individual photographed images that have been picked up during the 15 photographing mode. This can allow the user to take pictures without being conscious about positioning. With the motif being unchanged, generally, the photographing position is not changed during the photographing mode but when the user wants to change 20 the location, the user moves to a new location with the photographing mode disabled and initiates photographing with a new motif after enabling the photographing mode again. Even with single positioning performed when the photographing mode is ended, positional information 25 associated with a photographed image matches with the actual photographing location in most cases.

FIG. 18 is a flowchart showing a routine in the

case where positioning information is updated by a photographing interval and is adapted to a photographed image which is acquired thereafter.

In step 01 in FIG. 18, when the photographing mode
5 is selected, the control section 3 sends the positioning start instruction signal to the GPS processing section 1. When receiving the positioning start instruction signal from the control section 3, the GPS processing section 1 activates the GPS positioning apparatus to execute a reception process on radio waves received via the GPS antenna 1a, computes the local position (coordinates) of the digital camera 100 and sends the positioning result (computed value) to the control section 3. After completing one cycle
10 of positioning, the GPS processing section 1 proceeds to the next cycle of positioning, so that when receiving the positioning result from the GPS processing section 1, the control section 3 sends a positioning end instruction signal to the GPS processing section 1 to prevent the GPS processing section 1 from going to the next cycle and stop
15 positioning.
20

In the next step 03, the control section 3 stores the positioning result (positioning information)
25 received from GPS processing section 1 into the positioning result memory area in the RAM 3b (or DRAM 5).

Next, the control section 3 causes the timer to start measuring the time in step 05.

In step 07, the control section 3 sends a control signal to the image pickup section 2 to fetch a subject image. The image pickup section 2 stores the subject image (image data) into the DRAM 5 via the optical system. The fetched image is also subjected to through-display on the display section 7.

Next, the control section 3 checks the state signal sent from the operation section 4 in step 09. The control section 3 proceeds to step 023 when it is determined that the shutter button 46 has been depressed fully, but proceeds to step 011 otherwise.

In step 011, the control section 3 checks the time measured by the timer that has been started in step 05. The control section 3 proceeds to step 013 when the measured time elapses a predetermined time (e.g., 10 seconds), but returns to step 07 otherwise. This allows the control section 3 to check the time elapsed after the shutter operation is performed or the photographing mode is set. When the shutter operation is not performed over a predetermined time, it is considered that the user is moving with the photographing mode enabled in order to change the photographing location and positioning information can be updated as shown in steps 013, 015 and 017.

In step 013, the control section 3 sends the

positioning start instruction signal to the GPS processing section 1. When receiving the positioning start instruction signal from the control section 3, the GPS processing section 1 activates the GPS

5 positioning apparatus to execute a reception process on radio waves received via the GPS antenna 1a, computes the local position (coordinates) of the digital camera 100 and sends the positioning result (computed value) to the control section 3.

10 In step 015, the control section 3 checks if the GPS positioning process has been completed. When the GPS positioning process has been completed, the control section 3 controls the GPS processing section 1 in such a way that the GPS processing section 1 does not go to the next cycle. In step 017, the control section 3 overwrites the content of the positioning result in the RAM 3b (or DRAM 5) with the positioning result (positioning information) received from the GPS processing section 1, thus updating the positioning result, and then returns to step 07. When the GPS positioning process has not been completed yet, the control section 3 proceeds to step 019.

15 In step 019, the control section 3 checks if the shutter operation has been done during positioning. The control section 3 sends a control signal (positioning stop instruction signal) to the GPS processing section 1 in step 021 and proceeds to step

023, when the shutter operation has been performed, but proceeds to step 013 otherwise. When receiving the control signal from the control section 3, the GPS processing section 1 stops the positioning operation.

5 In step 023, the control section 3 performs compression on the photographed image stored in the DRAM 5 and stores the compressed image data (as a photographed image) in the flash memory 6. At this time, the positioning result (positioning information) stored in the RAM 3b in step 03 or step 013 is stored in association with the photographed image (image data).
10 In other words, when the shutter operation is sequentially carried out within a predetermined time from the start, the positioning result that is to be associated with a photographed image is the first positioning result that is held in step 03. When the shutter operation is carried out after the predetermined time passes, the positioning information updated in step 013 is associated with the photographed image that is acquired by that shutter operation (and photographed images obtained by the subsequent shutter operation which is executed at a predetermined time interval after the former shutter operation).

20 In step 025, the control section 3 checks the state signal from the operation section 4 to determine if there has been an operation to terminate the current photographing mode.

With the above-described structure, positioning is executed once at the beginning of the photographing mode (when the photographing mode is set on) and the positioning result is saved and when the photographing interval is too long, positioning is performed again to update the positioning result. Therefore, updated positioning information is associated with the photographed image after elapsing of a predetermined time. This can allow updated positioning information to be associated with the photographed image when the photographing location is changed during the photographing mode.

Positioning is carried out at a predetermined time interval when no picture is taken, but is stopped when a shutter operation is performed during positioning and the held positioning result is stored in association with each photographed image. Thus, the user can perform the shutter manipulation without being conscious about whether or not positioning is being carried out, except for the first positioning.

FIG. 19 is a flowchart showing a routine in the case where when a picture is taken during positioning after photographing, the positioning result is also adapted to that photographed image.

In step P1 in FIG. 19, when the photographing mode starts, the control section 3 sends a control signal to the image pickup section 2 to fetch a subject image.

The image pickup section 2 stores the subject image (image data) into the DRAM 5 via the optical system. The fetched image is also subjected to through-display on the display section 7.

5 Next, the control section 3 checks the state signal sent from the operation section 4 in step P3. When it is determined that the shutter button 46 has been depressed fully, the control section 3 considers that there is a photographing instruction and proceeds
10 to step P5.

In step P5, the control section 3 performs compression on the photographed image stored in the DRAM 5 and stores the compressed image data in the flash memory 6.

15 In the next step P7, the control section 3 sends the positioning start instruction signal to the GPS processing section 1. When receiving the positioning start instruction signal from the control section 3, the GPS processing section 1 activates the GPS positioning apparatus to start execute a reception process on radio waves received via the GPS antenna 1a and a positioning process, such as computation of the local position (coordinates) of the digital camera 100.
20 25

In the next step P9, the control section 3 also sends the control signal to the image pickup section 2 during the positioning by the GPS processing section 1 to fetch a subject image. The image pickup section 2

stores the subject image (image data) into the DRAM 5 via the optical system. The fetched image is also subjected to through-display on the display section 7.

Next, the control section 3 checks the state
5 signal sent from the operation section 4 in step P11. When it is determined that the shutter button 46 has been depressed fully, the control section 3 considers that there is a photographing instruction and proceeds to step P13. When otherwise, the control section 3
10 goes to step P15.

In step P13, the control section 3 performs compression on the photographed image stored in the DRAM 5 and stores the compressed image data in the flash memory 6. (In this case, an image counter
15 (initial value = 0) for counting the number of photographed images picked up and stored during positioning may be provided in the RAM 3b (or DRAM 5) and "1" may be added to the value of the image counter so as to facilitate decision in step P17.)

20 In the next step P15, when positioning is completed, the GPS processing section 1 sends the positioning result (computed value) to the control section 3. As the GPS processing section 1 goes to the next positioning process after one cycle of positioning
25 is completed, the control section 3 checks if the positioning result is received from the GPS processing section 1, and when such a positioning result is

received, the control section 3 determines that one cycle of positioning is completed and sends the positioning end instruction signal to the GPS processing section 1 to prevent the GPS processing 5 section 1 from going to the next cycle and stop the positioning process. The control section 3 then proceeds to step P17.

In step P17, the control section 3 checks if there is an image (photographed image) which has been picked up during positioning in the step P11 and has been stored in the step P13. The control section 3 goes to step P21 when there is a photographed image stored in step P13, but goes to step P19 otherwise. (In the case where the image counter is provided, when the value of 10 the image counter is equal to or greater than "1", the control section 3 sets the value of the counter to "0" before going to step P21, and when the value of the image counter is "0", the control section 3 goes to 15 step P19.)

20 In step P19, the control section 3 stores the positioning result received from the GPS processing section 1 in association with the photographed image stored in the flash memory 6 in the step P5, and then returns to step P1.

25 In step P21, the control section 3 stores the positioning result received from the GPS processing section 1 in association with the photographed images

stored in the flash memory 6 in the steps P5 and P13, and then returns to step P1 to perform the subsequent process of acquiring a next image.

With the above-described structure, positioning is
5 executed after photographing and storage of a
photographed image are completed, photographing is made
possible even during positioning, and when a picture is
taken during positioning, the photographed image is
stored, and after positioning is completed, the current
10 positioning result is saved in association with the
currently stored photographed image (also with an image
which has been picked up and stored during positioning).
This can allow the user to keep taking pictures without
being conscious about positioning.

15 When a photographing operation is performed during
positioning after photographing, a picture is allowed
to taken during positioning in the above-described
embodiment of FIG. 19. Alternatively, when a
photographing operation is performed during positioning
20 after photographing, positioning may be stopped and the
previous positioning information may be adapted to the
photographed image (including the image that has been
picked up during positioning in this case).

FIG. 20 is a flowchart illustrating a routine in
25 the case where when a picture is taken during
positioning after photographing, positioning is stopped
and previous positioning information is adapted to the

photographed image.

As processes in steps Q1, Q3, Q5, and Q7 in FIG. 20 are similar to those in steps P1, P3, P5, and P7, their description will be omitted.

When through-display of an image is performed in step Q9 in FIG. 20, the control section 3 checks the state signal sent from the operation section 4 to determine if the shutter button 46 has been fully depressed in step Q11. When determining that full depression of the shutter button 46 has occurred, the control section 3 considers that there is a photographing instruction and proceeds to step Q17. Otherwise, the control section 3 goes to step Q13.

In step Q17, the control section 3 sends a control signal (positioning stop instruction signal) to the GPS processing section 1 and then proceeds to step Q19. When receiving the control signal from the control section 3, the GPS processing section 1 stops the positioning operation.

In step Q19, the control section 3 performs compression on the image data stored in the DRAM 5 and stores it as a photographed image in the flash memory 6.

In step Q21, the control section 3 stores the positioning result received from the GPS processing section 1 previously (in step Q13) in association with the image data that has been stored in the flash memory 6 in the steps Q5 and Q19, and then returns to step Q1.

When positioning is completed in step Q13, the GPS processing section 1 sends the positioning result (computed value) to the control section 3. As the GPS processing section 1 goes to the next positioning process after one cycle of positioning is completed, the control section 3 checks if the positioning result is received from the GPS processing section 1, and when such a positioning result is received, the control section 3 determines that one cycle of positioning is completed and sends the positioning end instruction signal to the GPS processing section 1 to prevent the GPS processing section 1 from going to the next cycle and stop the positioning process. The control section 3 then proceeds to step Q15. The control section 3 overwrites the content of the positioning result memory area in the RAM 3b (DRAM 5) with the positioning result received from the GPS processing section 1.

With the above-described structure, positioning is executed after photographing and storage of a photographed image are completed, photographing is made possible even during positioning, and when a picture is taken during positioning, the photographed image is stored, and after positioning is completed, the current positioning result is saved in association with the currently stored photographed image. This can allow the user to keep taking pictures without being conscious about positioning. Alternatively, when a

photographing operation is performed during positioning,
positioning may be stopped (priority to photographing)
and a picture may be taken and the previous positioning
result may be stored in association with the image that
5 has been picked up this time in steps Q5 and Q19.

Accordingly, the user can perform the shutter operation
without being conscious about positioning at the time
of taking a picture.

10 FIG. 21 is a flowchart illustrating a routine in
the case where the result of positioning executed after
photographing is adapted to the photographed image.

In step R1 in FIG. 21, when the photographing mode
starts, the control section 3 sends a control signal to
the image pickup section 2 to fetch a subject image.

15 The image pickup section 2 stores the subject image
(image data) into the DRAM 5 via the optical system.
The fetched image is also subjected to through-display
on the display section 7.

20 In step R3, the control section 3 checks the state
signal sent from the operation section 4. When it is
determined that the shutter button 46 has been
depressed fully, the control section 3 considers that
there is a photographing instruction and proceeds to
step R5.

25 In step R5, the control section 3 performs
compression on the photographed image stored in the
DRAM 5 and stores the compressed image data as a

photographed image in the flash memory 6.

In the next step R7, the control section 3 sends the positioning start instruction signal to the GPS processing section 1. When receiving the positioning start instruction signal from the control section 3, 5 the GPS processing section 1 activates the GPS positioning apparatus to execute a reception process on radio waves received via the GPS antenna 1a, computes the local position (coordinates) of the digital camera 100 and sends the positioning result (computed value) to the control section 3. After completing one cycle 10 of positioning, the GPS processing section 1 proceeds to the next cycle of positioning, so that when receiving the positioning result from the GPS processing section 1, the control section 3 sends a 15 positioning end instruction signal to the GPS processing section 1 to prevent the GPS processing section 1 from going to the next cycle and stop positioning.

20 In the next step R9, the control section 3 stores the positioning result acquired in the step R7 (positioning information (position data (coordinate values) of the digital camera 100)) in association with the photographed image in the step R5. Then, the 25 control section 3 causes the timer to start measuring the time (initial value = 0) in step R10.

In step R11, the control section 3 sends a control

signal to the image pickup section 2 to fetch a subject image. The image pickup section 2 stores the subject image (image data) into the DRAM 5 via the optical system. The fetched image is also subjected to through-display on the display section 7.

In the next step R13, the control section 3 checks the state signal sent from the operation section 4. The control section 3 proceeds to step R17 when it is determined that the shutter button 46 has been depressed fully, but proceeds to step R15 otherwise.

In step R15, the control section 3 checks the time measured by the timer that has been started in step R10. The control section 3 returns to step R1 when the measured time elapses a predetermined time (e.g., 15 10 seconds), but returns to step R11 otherwise.

In step R17, the control section 3 performs compression on the photographed image stored in the DRAM 5 and stores the compressed image data as a photographed image in the flash memory 6. At this time, 20 the control section 3 stores the positioning result received from the GPS processing section 1 in the step R7 in association with the photographed image, sets the timer to "0" and returns to step R1 to execute the subsequent process of acquiring a next image.

The execution of the process in the step R17 is not limited to the case when there is no shutter operation done in step R13 (i.e., this step of

determining the elapsing time can be carried out at any of the timings of the steps R3 to R9).

With the above-described structure, positioning is executed after photographing and storage of a photographed image are completed, photographing is made possible within a predetermined period after positioning, and when a picture is taken within the predetermined time, the photographed image is stored, and the positioning result is saved in association with the stored photographed image. This can allow the user to keep taking pictures without being conscious about positioning (i.e., when the time elapsed after the shutter operation and no shutter operation is performed over a predetermined time, photographing is possible (steps S9 to S17)).

Note that the positioning timing for positioning information which is to be stored in association with the photographed image is not limited to the described one of the above-described embodiment.

For example, the structure may be modified in such a way that positioning is executed when the date or the date and hour are changed. Specifically, although positioning is performed when the camera is powered off or on in the examples of FIGS. 14 and 15 and positioning is performed when the photographing mode is enabled or disabled in the examples of FIGS. 16 and 17, a change in the date or the date and hour may be

determined in step K1 in FIG. 14 (or in step M1 in FIG. 16) and when there is such a change, positioning and storage of positioning information may be carried out in steps K3 and K5 (or steps M3 and M5). In this
5 case, when no change occurs in the date or the date and hour in step K1 (M1), the flow should go to step K7 (M7), and when photographing is not completed in steps K11 and K15 (M9 and M13), the flow should go to step K1 (M1).

10 Further, a change in the date or the date and hour may be determined in step L13 in FIG. 15 (or in step N9 in FIG. 17) and when there is such a change, positioning may be carried out in step L15 (N11). In this case, when no change occurs in the date or the
15 date and hour in step L13 (N9), the flow should go to step L17 (N13).

The structure may alternatively be modified in such a way that positioning is executed when a folder for storing photographed images is changed.

20 Specifically, the structure may be so modified as to be able to set (or selectively set) a holder for storing photographed images in step K1 in FIG. 14 (or in step M1 in FIG. 16), whereby when a folder is set (or selectively set), positioning and saving of
25 positioning information are performed in steps K3 and K5 (M3 and M5). In this case, when a holder is not set (or selectively set), the flow should go to step K7

(M7). Note that a folder is set on a saving memory such as the flash memory 6 by the setting (or selectively setting) operation. (A folder is set, for example, for each specific motif or for each photographing date.)

Alternatively, the structure may be so modified as to be able to set (or selectively set) a new holder or select an existing folder in step L13 in FIG. 15 (or in step N9 in FIG. 17), whereby when a folder is set (or selectively set), positioning is performed in step L15 (N11). In this case, when no holder is set (or selectively set) in step L13 (N9), the flow should go to step L17 (N13).

The above-described modified structures can also allow the user to take pictures without being conscious about positioning.

Further, positioning may be performed by a combination of the above-described methods illustrated in FIGS. 14 to 21. For instance, the structure may be so modified that positioning is not performed every time the camera is powered on or off but is performed only when the date is changed (a combination of the methods of FIGS. 14 and 15 and the methods of FIGS. 19 to 21).

Although the GPS processing section 1 goes to the next cycle of positioning after sending the positioning result (computed value) to the control section 3 in the

foregoing description of FIGS. 14 to 21, the structure
may be modified so that when one cycle of positioning
is performed and the positioning result is sent to the
control section 3, the positioning process is
5 interrupted or it is stopped until an instruction is
given from the control section 3.

Although the foregoing description of the
individual examples has been given of the case where
photographed images are stored in association with
10 positioning information in one to one correspondence at
the time of adapting the positioning information, the
stored photographed images may be associated with the
positioning information. (For example, an image
information list may be provided so that at the time of
15 storing photographed images, positioning information
and link information for the corresponding image are
recorded).

Although the photographing mode can be disabled
only for a predetermined time after photographing or
20 the camera can be powered off only for a predetermined
time after the photographing mode is disabled in the
above-described embodiment, the photographing mode may
be disabled at an arbitrary timing in the photographing
mode or the camera may be powered off at an arbitrary
25 timing while the power is on.

Alternatively, plural types of photographing modes
may be provided so that the positioning timing control

operation of this invention is performed only when a predetermined one of the photographing modes is selectively set, and positioning is performed for each photographing when the other photographing modes are selectively set.

The third embodiment of this invention will now be described.

[Method of Adapting Positioning Timing and Positioning Information to Photographed Image]

As mentioned earlier, if positioning is performed every time a picture is taken in the series photographing mode, the series photographing interval varies. According to this invention, therefore, series photographing is made possible at a given photographing interval by adapting positioning information obtained by positioning at a predetermined timing to each of serially photographed images (which are a plurality of photographed images that have been serially picked up at a given photographing interval by the series photographing capability). The adaptation of positioning information may be accomplished by one of the following three schemes. The first one is to store the same positioning information in association with each of serially photographed images in one to one correspondence. The second scheme is to associate one positioning information with each of serially photographed images and display the positioning

information in association with each image at the time of reproduction. Thirdly, positioning information which is obtained by interpolating positioning information that has been acquired at the beginning and
5 end of series photographing is adapted to each of the serially photographed images. The following will discuss several examples of the positioning timing control and the operation of adapting positioning information to photographed images.

10 FIG. 22 is a flowchart illustrating a routine in the case where positioning is performed before a series photographing start instruction is issued according to a third embodiment of this invention.

15 In step S1 in FIG. 22, when the photographing mode starts, the control section 3 reads process mode select menu data (or icon data) or the like from the program memory 3c and sends the data to the display section 7 and displays it on the screen, prompting the user to make a selection. The control section 3 checks the
20 state signal sent from the operation section 4. When the detailed function (mode) of the selected processing mode is the series photographing mode, the control section 3 goes to step S3.

25 In step S3, the control section 3 sends a control signal (positioning start instruction signal) to the GPS processing section 1. When receiving the positioning start instruction signal from the control

section 3, the GPS processing section 1 activates the GPS positioning apparatus to execute a reception process on radio waves received via the GPS antenna 1a, computes the local position (coordinates) of the 5 digital camera 100 and sends the positioning result (computed value) to the control section 3. As the GPS processing section 1 proceeds to the next cycle of positioning after completing one cycle of positioning (which means the process of the next reception cycle of 10 positioning information sent from a GPS satellite at a predetermined period), the control section 3 sends a control signal (positioning end instruction signal) to the GPS processing section 1, when receiving the positioning result from the GPS processing section 1, 15 to prevent the GPS processing section 1 from going to the next cycle and stop positioning.

Note that even if the user selects the series photographing mode and immediately gives the series photographing instruction (shutter operation), series 20 photographing does not start until positioning is completed. In this case, therefore, the display lamp 8 may be flickered to inform the user of positioning being in progress, so that the user will not be confused. Alternatively, a message or mark may be 25 displayed or blinked on the display section 7 or an alarm sound may be generated when the camera is equipped with a sound output device.

In step S5, the control section 3 holds (stores) the positioning result (positioning information) received from GPS processing section 1 into the positioning result memory area in the RAM 3b (or DRAM 5).

5

At this time, the display lamp 8 may be turned on (or off) to inform the user of the end of positioning or series photographing being possible. Alternatively, a message or mark may be displayed on the display section 7 or an alarm sound may be generated when the camera is equipped with a sound output device.

10

In step S7, the control section 3 sends a control signal to the image pickup section 2 to fetch a subject image. The image pickup section 2 stores the subject image (image data) into the through image memory area 51 in the DRAM 5 via the optical system. The fetched image is also subjected to through-display on the display section 7.

15

Next, the control section 3 checks the state signal sent from the operation section 4 in step S9. When it is determined that the shutter button 46 has been depressed fully, the control section 3 determines that there is a series photographing instruction and proceeds to step S11.

20

In step S11, the control section 3 stores (sequentially and accumulatively stores) images, fetched through the image pickup section 2, into the

series photographed image memory area 52 at a predetermined time interval. The fetched images are stored in the through image memory area 51 and are subjected to through-display on the display section 7.

5 When the digital camera 100 is so designed as to be able to permit a series-photographing release operation during series photographing (e.g., full depression of the shutter button 46 during series photographing), upon detection of the series-photographing release operation, the control section 3 stops accumulative storage of subsequent photographed images and goes to step S17.

10 In step S15, the control section 3 counts the number of images accumulatively stored in the series photographed image memory area 52, and determines that series photographing is completed when the count reaches a predetermined value, then proceeds to step S17. When the count has not reached the predetermined value, the control section 3 returns to step S11.

15 In step S17, the control section 3 reads the individual serially photographed images (image data), stored in the series photographed image memory area 52 in the DRAM 5 in the step S11, performs compression on the photographed images one after another and sequentially stores the compressed image data in the flash memory 6. At this time, the positioning result acquired in step S3 (the positioning result held in the

RAM 3b in step S5) is stored in association with each of the serially photographed images.

With the above-described structure, positioning is executed before series photographing starts and the 5 positioning result is stored in association with each of serially photographed images, so that the user can perform series photographing without being conscious about positioning. Further, as the positioning operation and the series photographing operation do not 10 overlap each other, it is possible to reduce the load originated from the positioning operation.

Although positioning information at the time of setting the series photographing mode is stored in association with each of serially photographed images 15 in the example of FIG. 22, positioning may be performed at a predetermined time interval during the series photographing mode and the positioning result immediately before the series photographing instruction may be associated with each of serially photographed 20 images.

FIG. 23 is a flowchart illustrating a routine in the case where positioning is performed after the series photographing start instruction is issued.

In step T1 in FIG. 23, when the photographing mode 25 starts, the control section 3 reads process mode select menu data or the like from the program memory 3c and sends the data to the display section 7 and displays it

on the screen, prompting the user to make a selection. The control section 3 checks the state signal sent from the operation section 4. When the detailed function (mode) of the selected processing mode is the photographing mode, the control section 3 goes to step T3.

In step T3, the control section 3 sends a control signal to the image pickup section 2 to fetch a subject image. The image pickup section 2 stores the subject image (image data) into the through image memory area 51 in the DRAM 5 via the optical system. The fetched image is also subjected to through-display on the display section 7.

In the next step T5, the control section 3 checks the state signal sent from the operation section 4. When it is determined that the shutter button 46 has been depressed fully, the control section 3 considers that there is a series photographing instruction and proceeds to step T7. In step T7, the control section 3 sends a control signal (positioning start instruction signal) to the GPS processing section 1. When receiving the positioning start instruction signal from the control section 3, the GPS processing section 1 activates the GPS positioning apparatus to execute a reception process on radio waves received via the GPS antenna 1a, computes the local position (coordinates) of the digital camera 100 and sends the positioning result (computed value) to the control section 3. As

the GPS processing section 1 proceeds to the next cycle of positioning after completing one cycle of positioning, the control section 3 sends a control signal (positioning end instruction signal) to the GPS processing section 1, when receiving the positioning result from the GPS processing section 1, to prevent the GPS processing section 1 from going to the next cycle and stop positioning.

In the next step T9, the control section 3 holds (stores) the positioning result (positioning information) received from GPS processing section 1 in the positioning result memory area in the RAM 3b (or DRAM 5), and then proceeds to step T11. As processes in steps T11 to T17 are similar to those in steps S11 to S17 in FIG. 22, their description will be omitted.

With the above-described structure, positioning is executed after the series photographing instruction is issued and the positioning result is saved in association with each of serially photographed images. Even if the camera is moved before the series photographing instruction is issued, therefore, the photographing start position can be associated with each of serially photographed images.

FIG. 24 is a flowchart illustrating a routine in the case where positioning is executed after series photographing is completed.

In step U1 in FIG. 24, when the photographing mode

starts, the control section 3 reads process mode select menu data or the like from the program memory 3c and sends the data to the display section 7 and displays it on the screen, prompting the user to make a selection.

5 The control section 3 checks the state signal sent from the operation section 4. When the detailed function (mode) of the selected processing mode is the photographing mode, the control section 3 goes to step U3.

10 In step U3, the control section 3 sends a control signal to the image pickup section 2 to fetch a subject image. The image pickup section 2 stores the subject image (image data) into the through image memory area 51 in the DRAM 5 via the optical system. The fetched image is also subjected to through-display on the display section 7.

15 In the next step U5, the control section 3 checks the state signal sent from the operation section 4. When it is determined that the shutter button 46 has been depressed fully, the control section 3 considers that there is a series photographing instruction and proceeds to step U7.

20 In step U7, the control section 3 accumulatively stores the images that are fetched through the image pickup section 2 into the series photographed image memory area 52 at a predetermined time interval. In step U8, the control section 3 stores the fetched images into the through image memory area 51 and then

performs through-display of the images on the display section 7.

In step U9, when the digital camera 100 is so designed as to be able to permit a series-photographing release operation during series photographing, upon detection of the series-photographing release operation, the control section 3 stops accumulative storage of subsequent photographed images and goes to step U11.

In step U11, the control section 3 counts the number of images accumulatively stored in the series photographed image memory area 52, and determines that series photographing is completed when the count reaches a predetermined value, then proceeds to step U13. When the count has not reached the predetermined value, the control section 3 returns to step U7.

In step U13, the control section 3 sends a control signal (positioning start instruction signal) to the GPS processing section 1. When receiving the positioning start instruction signal from the control section 3, the GPS processing section 1 activates the GPS positioning apparatus to execute a reception process on radio waves received via the GPS antenna 1a, computes the local position of the digital camera 100 and sends the positioning result to the control section 3. As the GPS processing section 1 proceeds to the next cycle of positioning after completing one cycle of positioning, the control section 3 sends a control

signal (positioning end instruction signal) to the GPS processing section 1, when receiving the positioning result from the GPS processing section 1, to prevent the GPS processing section 1 from going to the next cycle and stop positioning.

In the next step U15, the control section 3 performs compression on the individual serially photographed images (image data), stored in the series photographed image memory area 52 in the DRAM 5 in the step U7, one after another, and sequentially stores the compressed image data in the flash memory 6. At this time, the positioning result acquired in step U13 is stored in association with each of the serially photographed images.

With the above-described structure, positioning is executed immediately before serially photographed images or the like are stored and the positioning result is saved in association with each of serially photographed images, so that the user can perform series photographing without being conscious about positioning. Further, as the positioning operation and the series photographing operation do not overlap each other, it is possible to reduce the load originated from the positioning operation.

FIG. 25 is a flowchart exemplifying another routine in the case where positioning is executed after series photographing is completed. The operation from

step V1 to step V9 in FIG. 25 is similar to the operation from step U1 to step U9 in FIG. 24.

In step V11 in FIG. 25, the control section 3 counts the number of images accumulatively stored in the series photographed image memory area 52, and determines that series photographing is completed when the count reaches a predetermined value, then proceeds to step V13. When the count has not reached the predetermined value, the control section 3 returns to step V7.

In the next step V13, the control section 3 performs compression on the individual serially photographed images (image data), stored in the series photographed image memory area 52 in the DRAM 5 in the step V7, one after another, and sequentially stores the compressed image data in the flash memory 6.

Next, the control section 3 sends a control signal (positioning start instruction signal) to the GPS processing section 1 in step V15. When receiving the positioning start instruction signal from the control section 3, the GPS processing section 1 activates the GPS positioning apparatus to execute a reception process on radio waves received via the GPS antenna 1a, computes the local position of the digital camera 100 and sends the positioning result to the control section 3 in step K3. As the GPS processing section 1 proceeds to the next cycle of positioning after completing one

cycle of positioning, the control section 3 sends a control signal (positioning end instruction signal) to the GPS processing section 1, when receiving the positioning result from the GPS processing section 1, 5 to prevent the GPS processing section 1 from going to the next cycle and stop positioning.

In the next step V17, the control section 3 stores the positioning result acquired in the step V15 in the flash memory 6 in association with the individual 10 serially photographed images that has been stored in the flash memory 6 in the step V13.

FIG. 26 is a flowchart illustrating a routine in the case where positioning is executed during series photographing.

15 In step W1 in FIG. 26, when the photographing mode starts, the control section 3 reads process mode select menu data or the like from the program memory 3c and sends the data to the display section 7 and displays it on the screen, prompting the user to make a selection. 20 The control section 3 checks the state signal sent from the operation section 4. When the detailed function (mode) of the selected processing mode is the photographing mode, the control section 3 goes to step W3.

25 In step W3, the control section 3 sends a control signal to the image pickup section 2 to fetch a subject image. The image pickup section 2 stores the subject image (image data) into the through image memory area

51 in the DRAM 5 via the optical system. The fetched image is also subjected to through-display on the display section 7.

5 In the next step W5, the control section 3 checks the state signal sent from the operation section 4. When it is determined that the shutter button 46 has been depressed fully, the control section 3 considers that there is a series photographing instruction and executes step W7 and step W15 in parallel.

10 In step W7, the control section 3 accumulatively stores the images that are fetched through the image pickup section 2 into the series photographed image memory area 52 at a predetermined time interval. Further, the control section 3 stores the fetched images into the through image memory area 51 and then performs through-display of the images on the display section 7. While steps W7 and W9 are carried out, GPS positioning as illustrated in steps W15 and W17 is executed in parallel.

15 20 In step W9, the control section 3 counts the number of images accumulatively stored in the series photographed image memory area 52, and determines that series photographing is completed when the count reaches a predetermined value, then proceeds to step W11. When the count has not reached the predetermined value, the control section 3 returns to step W7 to start the next series photographing operation.

When the digital camera 100 is so designed as to be able to permit a series-photographing release operation during series photographing (e.g., full depression of the shutter button 46 during series photographing), upon detection of the series-photographing release operation, the control section 3 stops accumulative storage of subsequent photographed images and goes to step W11.

The control section 3 waits for GPS positioning (step W15) in the parallel operation to end in step W11, and then proceeds to step W13. Specifically, the control section 3 checks if the positioning result is held in the positioning result memory area in the RAM 3b, and determines that GPS positioning has been completed when the positioning result is held in the positioning result memory area, and then goes to step W13.

When no positioning result is held in the positioning result memory area, on the other hand, the control section 3 waits for the positioning result (computed value) to be sent from the GPS processing section 1 and determines that GPS positioning has been completed upon reception of the positioning result, and sends the positioning end instruction signal to the GPS processing section 1. After the operation in step W15 is completed, the control section 3 goes to step W13. When receiving the positioning result from the GPS

processing section 1 at the same time a predetermined number of images are stored in the series photographed image memory area 52 (or the series-photographing release operation is performed) in the step T5, the 5 control section 3 immediately sends the positioning end instruction signal to the GPS processing section 1 and proceeds to step W13 after the operation in step W15 is completed.

In step W13, the control section 3 reads the 10 individual serially photographed images (image data), stored in the series photographed image memory area 52 in the DRAM 5 in the step W7, performs compression on the photographed images one after another and sequentially stores the compressed image data in the 15 flash memory 6. At this time, the positioning result acquired in the step W15 (the positioning result held in the positioning result memory area in the RAM 3b in step W17) is stored in the flash memory 6 in association with each of the serially photographed 20 images.

When the shutter button 46 is fully depressed in step W5, the control section 3 sends a control signal (positioning start instruction signal) to the GPS processing section 1 in step W15. When receiving the 25 positioning start instruction signal from the control section 3, the GPS processing section 1 activates the GPS positioning apparatus to execute a reception

process on radio waves received via the GPS antenna 1a, computes the local position (coordinates) of the digital camera 100 and sends the positioning result (computed value) to the control section 3. As the GPS processing section 1 proceeds to the next cycle of positioning after completing one cycle of positioning, the control section 3 sends the positioning end instruction signal to the GPS processing section 1 before preceding to step W17.

In step W17, the control section 3 saves (stores) the positioning result (positioning information), received from the GPS processing section 1, in the positioning result memory area in the RAM 3b (or DRAM 5).

The above-described structure can allow positioning to be executed during series photographing and the latest positioning result to be associated with the serially photographed images.

In the example of FIG. 26, positioning is executed in parallel to the photographing operation while a predetermined number of photographed images are stored in the DRAM 5 (or until releasing series photographing is instructed), and after the predetermined number of photographed images are stored there (or releasing series photographing is instructed), the positioning result is stored in association with all the photographed images (serially photographed images).

However, positioning may be executed every time a picture is taken and the positioning result may be held in the RAM 3b in association with each photographed image, and after a predetermined number of photographed images are stored there (or releasing series photographing is instructed), the individual photographed images and the positioning result associated with those photographed images may be stored.

In this case, the latest positioning result can be stored in association with each serially photographed image, so that the latest camera position can be associated with individual images even in the case where the photographing location at the beginning of series photographing differs from the photographing location at the end of series photographing, as in the case of serially taking pictures with a camera in motion such as an on-board camera.

FIG. 27 is a flowchart illustrating a routine in the case where positioning information which is interpolated for each of serially photographed images based on positioning information at the beginning and end of series photographing is adapted.

In step X1 in FIG. 27, when the photographing mode starts, the control section 3 reads process mode select menu data or the like from the program memory 3c and sends the data to the display section 7 and displays it on the screen, prompting the user to make a selection.

The control section 3 checks the state signal sent from the operation section 4. When the detailed function (mode) of the selected processing mode is the photographing mode, the control section 3 goes to step X3.

5 In step X3, the control section 3 sends a control signal to the image pickup section 2 to fetch a subject image. The image pickup section 2 stores the subject image (image data) into the through image memory area 51 in the DRAM 5 via the optical system. The fetched 10 image is also subjected to through-display on the display section 7.

 In the next step X5, the control section 3 checks the state signal sent from the operation section 4. When it is determined that the shutter button 46 has 15 been depressed fully, the control section 3 considers that there is a series photographing instruction and proceeds to step X7.

 In step X7, the control section 3 sends a control signal (positioning start instruction signal) to the GPS processing section 1. When receiving the positioning start instruction signal from the control section 3, the GPS processing section 1 activates the GPS positioning apparatus to execute a reception process on radio waves received via the GPS antenna 1a, 20 computes the local position of the digital camera 100 and sends the positioning result to the control section 3. As the GPS processing section 1 proceeds to the

next cycle of positioning after completing one cycle of positioning, the control section 3 sends a control signal (positioning end instruction signal) to the GPS processing section 1, when receiving the positioning result from the GPS processing section 1, to prevent the GPS processing section 1 from going to the next cycle and stop positioning. The control section 3 stores the current positioning result in the positioning result memory area.

In step X9, the control section 3 accumulatively stores the images that are fetched through the image pickup section 2 into the series photographed image memory area 52 at a predetermined time interval. Further, the control section 3 stores the fetched images into the through image memory area 51 and then performs through-display of the images on the display section 7.

In step X11, the control section 3 counts the number of images accumulatively stored in the series photographed image memory area 52, and determines that series photographing is completed when the count reaches a predetermined value, then proceeds to step X13. When the count has not reached the predetermined value, the control section 3 returns to step X9 to start the next series photographing operation.

When the digital camera 100 is so designed as to be able to permit a series-photographing release

operation during series photographing (e.g., full depression of the shutter button 46 during series photographing), upon detection of the series-photographing release operation, the control section 3
5 stops accumulative storage of subsequent photographed images and goes to step X13.

In step X13, the control section 3 sends a control signal (positioning start instruction signal) to the GPS processing section 1. When receiving the
10 positioning start instruction signal from the control section 3, the GPS processing section 1 activates the GPS positioning apparatus to execute a reception process on radio waves received via the GPS antenna 1a, computes the local position of the digital camera 100
15 and sends the positioning result to the control section 3. As the GPS processing section 1 proceeds to the next cycle of positioning after completing one cycle of positioning, the control section 3 sends a control signal (positioning end instruction signal) to the GPS processing section 1, when receiving the positioning result from the GPS processing section 1, to prevent the GPS processing section 1 from going to the next
20 cycle and stop positioning.

In step X15, the control section 3 computes an estimated photographing location (coordinates) of each of serially photographed images based on the positioning result at the beginning of series
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photographing, held in the step X7, and the positioning result at the end of series photographing, acquired in the step 13. The following shows how to compute the estimated photographing location.

Given that the number of serially photographed images $N = 16$, the photographing location at the beginning of series photographing is (X_1, Y_1) and the photographing location at the end of series photographing is (X_{16}, Y_{16}) , then an interpolated value in the X direction, Δx , and an interpolated value in the Y direction, Δy , become as follows.

$$\Delta x = |X_1 - X_{16}| \div 15$$

$$\Delta y = |Y_1 - Y_{16}| \div 15$$

From those equations, the photographing locations of the first, second, third, ..., fifteenth and sixteenth serially photographed images can be obtained as (X_1, Y_1) , $(X_1 + \Delta x, Y_1 + \Delta y)$, $(X_1 + 2\Delta x, Y_1 + 2\Delta y)$, ..., $(X_1 + 14\Delta x, Y_1 + 14\Delta y)$ and (X_{16}, Y_{16}) . If an error is negligible, $(X_{16}, Y_{16}) = (X_1 + 15\Delta x, Y_1 + 15\Delta y)$. It is to be noted however that if $\Delta x < \alpha$ and $\Delta y < \beta$ (α and β being predetermined (lower) values), $\Delta x = 0$ and $\Delta y = 0$.

In step X17, the control section 3 performs compression on the individual serially photographed images (image data), stored in the series photographed image memory area 52 in the DRAM 5 in the step Y9, one after another, and sequentially stores the compressed image data in the flash memory 6 as serially

photographed images. At this time, the positional information (coordinates) computed in the aforementioned step X15 is stored in association with each of the serially photographed images.

5 With the above-described structure, positioning information interpolated for each serially photographed image based on positioning information at the beginning and end of series photographing can be adapted. Therefore, an estimated photographing location can be
10 associated with each image even in the case where the photographing location at the beginning of series photographing differs from the photographing location at the end of series photographing, as in the case of serially taking pictures with a camera in motion in
15 responsive to a moving subject or the case of serially taking pictures with an on-board camera.

Although the number of interpolated values equals to the number of serially photographed images in the foregoing description, interpolated values which are less in number than serially photographed images, e.g., only one interpolated value, may be computed and stored in association with the individual serially photographed images.

20 Although the GPS processing section 1 proceeds to the next cycle of positioning after sending the positioning result (computed value) to the control section 3, the structure may be modified so that when

one cycle of positioning is performed and the positioning result is sent to the control section 3, the positioning process is interrupted or it is stopped until an instruction is given from the control section 3.

Although the foregoing description has been given of the positioning timing control operation or the like in the series photographing mode, this invention is also adaptable to a quick shot mode which can ensure photographing by the number of shutter operations (there is an upper limit) that are performed within a predetermined time.

Although coordinates (longitude, latitude) are used as positional information (positioning information) and are associated with each of serially photographed images, a place name, a facility name or the like according to coordinates may be stored as positional information in association with each serially photographed image.

Further, the digital camera 100 may be equipped with a communication interface and communication capability, so that the positioning result (computed value) stored data can be transmitted to an external device over a communication network, such an Internet.

Furthermore, the photographing instruction means is not limited to the shutter of the camera, but may be operable in responsive to a remote operation via a

remote controller or a communication line (radio communication line).

Additional advantages and modifications will readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details and representative embodiments shown and described herein. Accordingly, various modifications may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents.

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